# Newcastle Island Passage and Nanaimo Harbour Fish Habitat Inventory

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# NEWCASTLE ISLAND PASSAGE AND NANAIMO HARBOUR FISH HABITAT INVENTORY

by

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## ABSTRACT

A biophysical inventory describing the fish habitat characteristics of the marine foreshore of Newcastle Island Passage and Nanaimo Harbour was conducted to assist in the planning of future waterfront developments in the area. Fish habitat characteristics of the marine foreshore were observed visually from a boat, from land, and by divers, using S.C.U.B.A. The inventory describes sixty-two reaches in Newcastle Island Passage and Nanaimo Harbour based on substrate and/or vegetation composition. The location and size of intertidal mudflats and eelgrass beds, which are sensitive fish habitat areas, are also described.

The importance of fish habitat in the study area is assessed using salmonid escapement data, and the records of fish, shellfish, crustacean, and other invertebrate use. In addition, human use of the foreshore is described from visual observations made during the survey.

Recommendations for management of highly productive fish habitat in Newcastle Island Passage and Nanaimo Harbour are provided.

## RÉSUMÉ

Afin d'aider à la planification du futur développment du front de mer, on a effectué un relevé biophysique descriptif des caractéristiques de l'habitat du possion dans la laisse de mer située dans le passage de l'Île de Newcastle et dans le port de Nanaimo. Un relevé visuel des caractéristiques de l'habitat du possion dans la laisse de mer a été fait d'un bateau, de la terre ferme et par l'intermédiaire de plongeurs revêtus d'un scaphandre. Le relevé, qui décrit soixante-deux secteurs du passage de l'Île de Newcastle et du port de Nanaimo, est basé sur la composition du substrat et de la végétation. Ce document relève également l'emplacement et la dimension des slikkes interdidales et des zones tapissées de zostères, zones fragiles d'habitat ichtyocole.

Dans le secteur étudié, l'importance de l'habitat ichtyocole a été évaluée au moyen des données recueillies sur la remonte des salmonidés et de la documentaion accumulée sur l'habitiat des poissions, des coquillages, des crustacés et des autres invertébrés. Le document fait en outre état de l'utilisation de la laisse de mer par les hommes, à partir d'observations visuelles faites pendant le relevé.

Enfin, le document fournit des recommendations relatives à la gestion de cet habitat ichtyocole très productif que constituent le passage de l'Île de Newcastle et le port de Nanaimo.

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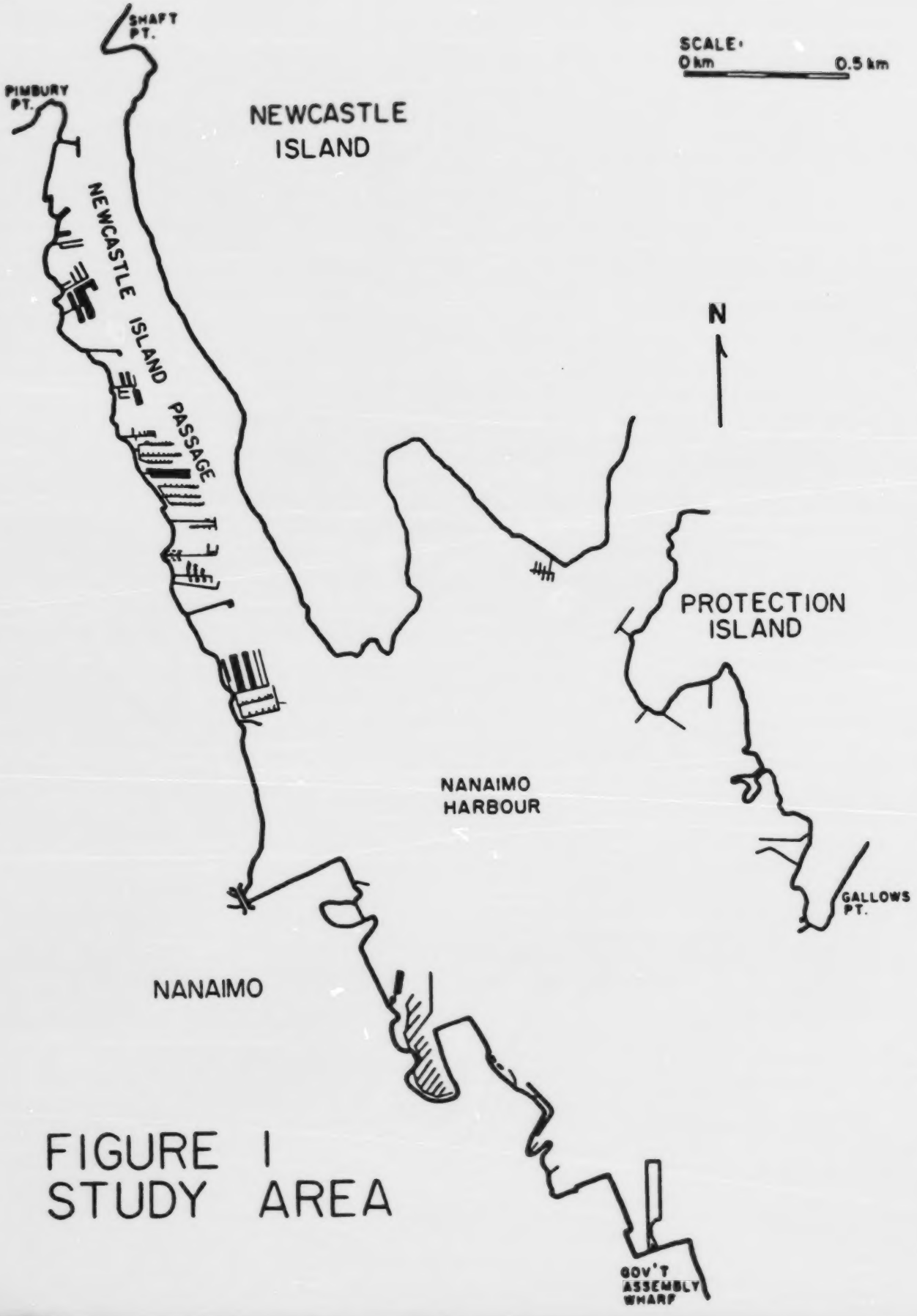



FIGURE 1
STUDY AREA

## 1.0 Introduction

The Nanaimo area serves as a deep sea port with fishing, lumbering, trading, servicing and distribution industries making it one of the most prosperous communities on the west coast of British Columbia (Federal Labour Minister, Pierre Cadieux).

The Nanaimo area also provides extensive fish habitat areas along its marine foreshore. These habitat areas are heavily utilized by juvenile salmonids, from both the Millstone and Nanaimo Rivers, as well as juvenile herring and several other types of marine organisms.

As the Nanaimo area grows, the marine foreshore will be subject to increased pressure from commercial, industrial, and private developers which, in turn, means increased pressure on fish habitat areas.

Although extensive biophysical habitat information has been collected for the Nanaimo River estuary, very little information has been collected for the foreshore areas north of the estuary. It is the intent of this study to add to the existing habitat information for the marine foreshore of Newcastle Island Passage and Nanaimo Harbour. This information will be used to identify fish habitat areas in these two waterways and to assist in the planning of future waterfront developments.

## 2.0 The Study Area

The city of Nanaimo is located on the east coast of southern Vancouver Island. The foreshore areas around Nanaimo are protected from the open waters of the Strait of Georgia by Newcastle Island and Protection Island. It is these two islands that make up the Nanaimo waterfront known as Newcastle Island Passage and Nanaimo Harbour.

For the purpose of this report, the study area includes Newcastle Island Passage and Nanaimo Harbour from a line drawn between Pimbury Point and Shaft Point in the north to a line drawn between the Government Assembly Wharf and Gallows Point on Protection Island in the south (Figure 1).

To describe the biophysical characteristics of the study area, the marine foreshore was divided into reaches based on either a change in substrate, a change in vegetation, or both. These reaches are shown in Figure 2.

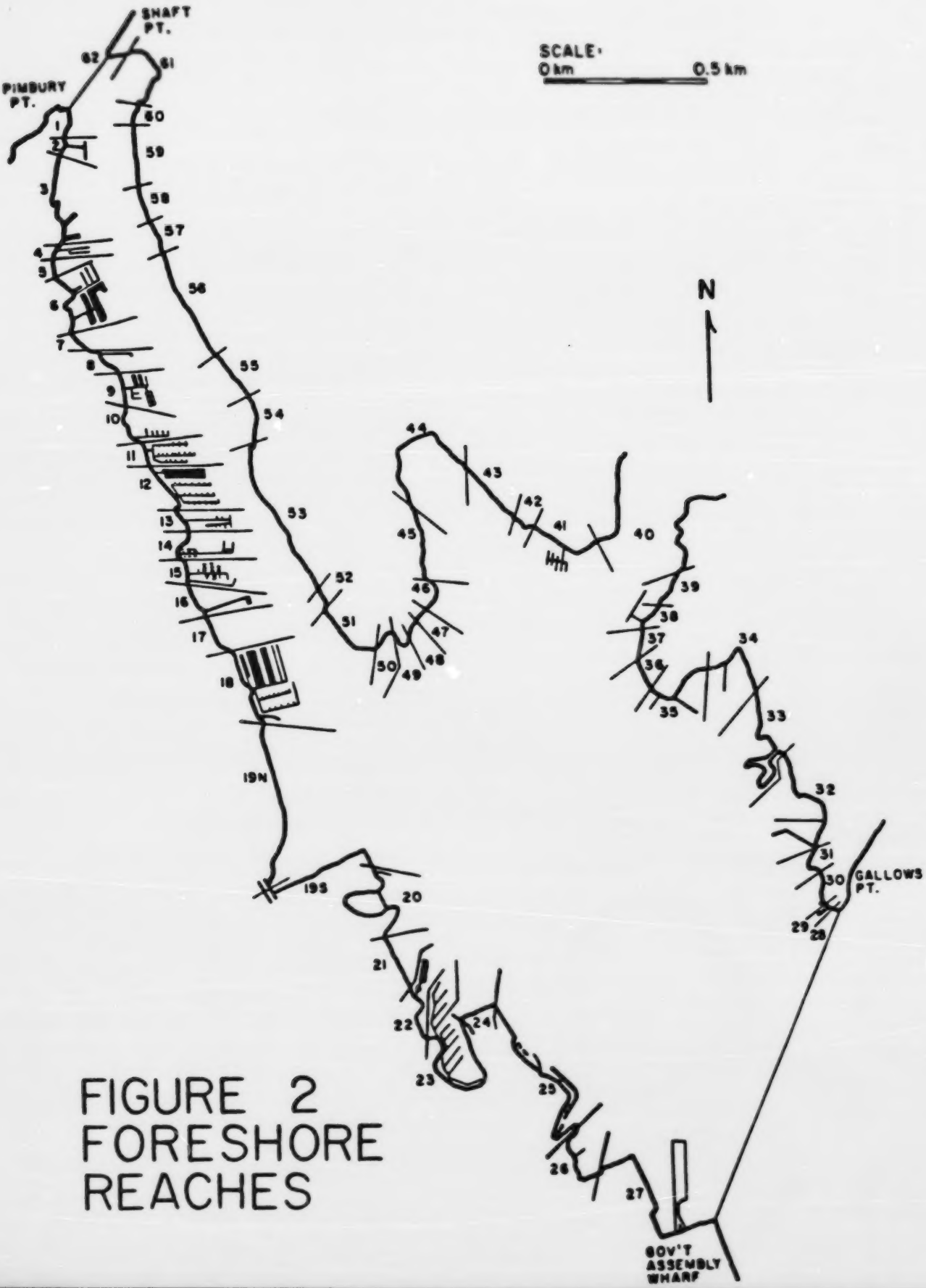



FIGURE 2
FORESHORE
REACHES

## 3.0 Inventory Methods/Information Sources

Depth contours in the study area were taken from Canadian Hydrographic Service Chart No. 3457.

Substrate and vegetation characteristics in Newcastle Island Passage and Nanaimo Harbour were assessed in shallow waters both from a small boat and from land at low tide. In deeper waters these two characteristics were assessed by divers, using S.C.U.B.A. Substrate and vegetation characteristics were noted visually and recorded on 1:8000 scale charts.

Utilization of Newcastle Island Passage and Nanaimo Harbour by salmon, herring, shellfish, and crustaceans has been documented by fisheries officers and management biologists for several years. This information is summarized in respective sections, tables, and figures.

The presence of fish, shellfish, crustaceans, and other invertebrates were also recorded by divers, using S.C.U.B.A.

Intertidal mudflat areas in Newcastle Island Passage and Nanaimo Harbour were assessed using recorded depth contour, substrate, and vegetation data.

Foreshore use of the study area was noted visually both from a small boat and from land.

## 4.0 Physical Characteristics

### 4.1 Depth Contours

The majority of Newcastle Island Passage and Nanaimo Harbour is shallow, providing less than 7 metres of water at zero tide. The deepest area occurs at the southern limit of Nanaimo Harbour where the depth exceeds 10 metres. Both the marine foreshore on the west side of Newcastle Island Passage and the east side of Nanaimo Harbour have low gradient downward slopes thus providing extensive drying areas at low tide. The rest of the marine foreshore in the study area is steep and provides very little intertidal area.

Table 1. Substrate Composition of Foreshore Reaches Defined In Newcastle Island Passage and Nanaimo Harbour.

*Depths are given in metres above zero tide which at Nanaimo is three metres below mean water level.

B=bedrock and/or boulders; C=cobble; S=sand; M=mud/silt; W=concrete wall; P=pilings

| Reach/Type/Depth | | | Reach/Type/Depth | | | Reach/Type/Depth | | | Reach/Type/Depth | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | B | >1.2 | 19N | WB | >2.5 | 34 | M | <4.9 | 50 | S | 4.9-0.3- |
| | M | <1.2 | | M | <2.5 | 35 | B | >1.2 | | M | <0.3- |
| 2 | B | >4.3 | 19S | B | >1.5 | | S | 1.2-0.5- | 51 | B | <2.0 |
| | C | 4.3-2.5 | | M | <1.5 | | M | <0.5- | | S | 2.0-0.0 |
| | M | <2.5 | 20 | B | >1.0 | 36 | B | 4.9-0.0 | | M | <0.0 |
| 3 | B | >4.3 | | CM | <1.0 | | M | <0.0 | 52 | S | 4.9-0.5 |
| | C | 4.3-2.5 | 21 | B | >0.6 | 37 | B | >1.0 | | M | <0.5 |
| | SM | <2.5 | | MC | <0.6 | | S | 1.0-0.5- | 53 | B | >2.7 |
| 4 | B | >4.3 | 22 | B | >1.0 | | M | <0.5- | | S | 2.7-0.0 |
| | C | 4.3-2.5 | | SM | <1.0 | 38 | SC | 4.9-0.0 | | M | <0.0 |
| | SM | <2.5 | 23 | BC | >0.6 | | M | <0.0 | 54 | B | >3.0 |
| 5 | B | >2.5 | | M | <0.6 | 39 | B | >1.2 | | S | 3.0-0.0 |
| | M | <2.5 | 24 | W | >1.8 | | S | 1.2-0.5- | | M | <0.0 |
| 6 | B | >2.5 | | B | 1.8-0.6 | | M | <0.5- | 55 | B | >1.0 |
| | M | <2.5 | | S | 0.6-0.0 | 40 | SC | 4.9-0.0 | | S | 1.0-0.5- |
| 7 | B | >2.0 | | M | <0.0 | | M | <0.0 | | M | <0.5- |
| | M | <2.0 | 25 | B | >1.0 | 41 | B | >1.2 | 56 | B | >0.3- |
| 8 | B | >2.0 | | SC | 1.0-0.0 | | S | 1.2-0.5- | | S | 0.3-0.5- |
| | M | <2.0 | | M | <0.0 | | M | <0.5- | | M | <0.5- |
| 9 | B | >2.0 | 26 | SC | 4.9-0.0 | 42 | B | >0.6 | 57 | B | >0.3- |
| | M | <2.0 | | M | <0.0 | | S | 0.6-0.5- | | S | 0.3--0.5- |
| 10 | B | >2.5 | 27 | P | <4.9 | | M | <0.5- | | M | <0.5- |
| | M | <2.5 | 28 | CS | 4.9-0.0 | 43 | B | >1.5 | 58 | B | >0.3- |
| 11 | B | >2.5 | | M | <0.0 | | S | 1.5-0.0 | | S | 0.3--0.5- |
| | M | <2.5 | 29 | B | >0.6 | | M | <0.0 | | M | <0.5- |
| 12 | B | >2.0 | | S | 0.6-0.5- | 44 | M | <4.9 | 59 | B | >1.0 |
| | M | <2.0 | | M | <0.5- | 45 | B | >2.4 | | S | 1.0-0.5- |
| 13 | MC | >2.0 | 30 | S | 4.9-0.5- | | M | <2.4 | | M | <0.5- |
| | M | <2.0 | | M | <0.5- | 46 | B | >1.5 | 60 | B | >2.1 |
| 14 | C | >2.5 | 31 | B | >1.0 | | M | <1.5 | | S | 2.1-0.0 |
| | M | <2.5 | | S | 1.0-0.5- | 47 | B | >0.0 | | M | <0.0 |
| 15 | C | >2.5 | | M | <0.5- | | M | <0.0 | 61 | CS | 4.9-0.3 |
| | M | <2.5 | 32 | B | >3.0 | 48 | B | >1.2 | | M | <0.3 |
| 16 | BC | >2.5 | | S | 3.0-0.0 | | S | 1.2-0.3- | 62 | B | >2.1 |
| | M | <2.5 | | M | <0.0 | | M | <0.3- | | S | 2.1-0.0 |
| 17 | BC | >2.5 | 33 | B | >1.2 | 49 | B | >1.2 | | M | <0.0 |
| | M | <2.5 | | S | 1.2-0.5- | | S | 1.2-0.3- | | | |
| 18 | BC | >2.7 | | M | <0.5- | | M | <0.3- | | | |
| | M | <2.7 | | | | | | | | | |

## 4.2 Substrate

Foreshore substrate characteristics for reaches in Newcastle Island Passage and Nanaimo Harbour are listed in Table 1. Substrate composition was recorded from the high water line, which at Nanaimo is 4.9 metres above mean water level, to the visible upper subtidal. For the purpose of this inventory, substrate material was classified into six categories:

B - bedrock and/or boulders
C - cobble
S - sand
M - mud/silt
W - concrete wall
P - pilings

In several cases, more than one material type was present at the same depth in each reach. In this case, the symbol for the dominant material was presented first.

The majority of the west shore of Newcastle Island Passage and Nanaimo Harbour has been filled with boulders. This boulder substrate was observed to range from the high water line to 0.5 metres above zero tide. In a majority of the reaches, however, boulders extend only to 2.5 metres. Below the boulders, the substrate usually changes to mud. The east shore of Newcastle Island Passage and Nanaimo Harbour is characterized by exposed bedrock and boulders. The extent of this substrate was observed to range from the high water line to 0.3 metres below zero tide. In most reaches, however, bedrock and/or boulders extend only down to 1.2 metres. Below the bedrock and boulders, the substrate usually changes to sand. This sand extends to approximately 0.3 metres below zero tide where the substrate changes to mud.

Table 2. Vegetation Composition of Foreshore Reaches Defined in Newcastle Island Passage and Nanaimo Harbour.

*Depths are given in metres above zero tide which at Nanaimo is 3.0 metres below mean water level.

R-rockweed; G-Enteromorpha; L-laminaria; U-ulva;
E-eelgrass; J-japweed; NV-no vegetation
Density 1-sparse 2-moderate 3-dense

| Reach | Type | Depth | Reach | Type | Depth | Reach | Type | Depth | Reach | Type | Depth |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | R1 | 4.3-2.7 | 19N | U1 | 3.4-2.5 | 34 | G1 | 1.8-1.2 | 50 | R1 | 4.3-2.8 |
| | G2 | 2.7-1.5 | | G1 | 2.5-1.0 | | E2 | 1.0-1.0- | | G1 | 2.5-1.5 |
| | L2 | 1.5-2.0- | | E3 | 1.0-1.8- | 35 | R2 | 4.3-1.8 | | E2 | 1.0-3.0- |
| | E2 | 3.0-1.8- | | L3 | 1.0-2.0- | | G1 | 1.8-1.2 | 51 | R3 | 4.3-2.1 |
| 2 | G1 | 2.7-2.1 | 19S | R3 | 4.0-2.8 | | E2 | 1.0-1.5- | | G1 | 2.1-1.2 |
| | L1 | 1.0-1.5- | | G1 | 2.5-1.5 | 36 | G1 | 2.5-1.0 | | E2 | 1.0-3.0- |
| | NV | underdock | | U1 | 2.5-1.5 | | E2 | 1.0-2.0- | 52 | R2 | 4.3-2.1 |
| 3 | R1 | 4.3-3.5 | | E3 | 1.0-1.8- | 37 | R2 | 4.3-2.5 | | G1 | 2.1-1.2 |
| | G2 | 2.7-2.1 | | L3 | 1.0-2.0- | | G1 | 2.5-1.0 | | E2 | 1.0-3.0- |
| | E3 | 0.6-1.5- | 20 | G2 | 2.0-1.0 | | E2 | 1.0-2.0- | 53 | R3 | 4.3-2.1 |
| 4 | G1 | 2.7-2.1 | | L2 | 0.6-2.0- | 38 | R2 | 4.3-2.7 | | G1 | 2.1-1.2 |
| | L1 | 1.0-1.5- | | E2 | 0.6-1.5- | | E2 | 1.0-2.0- | | E2 | 1.0-3.0- |
| | NV | underdock | 21 | R3 | 4.3-2.5 | 39 | R2 | 4.3-1.8 | 54 | R2 | 4.3-1.5 |
| 5 | G1 | 2.7-2.1 | | G1 | 2.0-0.6 | | G1 | 1.8-1.0 | | G1 | 1.5-1.0 |
| 6 | G2 | 3.5-1.8 | | E2 | 0.6-1.5- | | E2 | 1.0-2.0- | | E2 | 1.0-3.0- |
| | L1 | 1.0-1.5- | | L1 | 0.3-2.0- | 40 | G1 | 1.8-1.0 | 55 | R2 | 4.3-1.5 |
| | NV | underdock | 22 | R1 | 4.3-1.8 | | E2 | 0.6-2.0- | | G1 | 1.5-1.0 |
| 7 | G2 | 3.4-1.8 | | G1 | 1.5-1.0 | 41 | R1 | 4.3-1.2 | | E2 | 0.6-3.0- |
| | L1 | 1.0-1.5- | 23 | R1 | 4.3-1.8 | | G1 | 1.5-1.0 | 56 | R2 | 4.3-2.5 |
| 8 | G1 | 3.4-1.8 | | G1 | 1.8-1.0 | | E2 | 1.0-2.0- | | G1 | 2.7-1.5 |
| 9 | G1 | 2.7-1.8 | | NV | underdock | 42 | G1 | 1.5-0.6 | | L1 | 1.0-2.0- |
| | L1 | 1.0-1.5- | 24 | R1 | 4.3-1.8 | 43 | R2 | 4.3-1.5 | 57 | G1 | 2.7-1.5 |
| | E2 | 0.6-1.5- | | G2 | 1.8-0.6 | | G1 | 1.5-0.6 | 58 | R1 | 4.3-2.5 |
| | NV | underdock | 25 | R1 | 3.0-1.5 | 44 | G2 | 2.5-1.0 | | G2 | 2.5-1.0 |
| 10 | G1 | 2.7-1.8 | | E1 | 2.0-0.0 | | L1 | 1.0-1.5- | 59 | R2 | 4.3-2.7 |
| | L2 | 1.0-1.5- | | U1 | 1.5-1.0 | 45 | R3 | 4.3-2.4 | | G2 | 2.7-1.2 |
| | E2 | 0.6-1.5- | | L2 | 1.2-2.0- | | G1 | 2.4-1.0 | | J1 | 1.2-1.0 |
| | NV | underdock | | J1 | 1.0-0.6 | 46 | R2 | 4.3-1.8 | | E2 | 0.6-3.0- |
| 11 | G1 | 2.4-1.8 | 26 | G2 | 3.0-1.2 | | G1 | 1.8-1.2 | 60 | R2 | 4.3-3.0 |
| | NV | underdock | 27 | NV | | | E2 | 1.0-2.0- | | G2 | 3.0-1.2 |
| 12 | NV | | 28 | NV | | 47 | R3 | 4.3-1.8 | | E2 | 0.6-3.0- |
| 13 | G1 | 3.0-1.8 | 29 | G1 | 3.0-1.0 | | G1 | 1.8-1.2 | 61 | G1 | 1.5-1.0 |
| 14 | G1 | 2.7-1.2 | 30 | G1 | 1.2-1.0 | | E2 | 1.0-2.0- | | L1 | 0.6-1.5- |
| 15 | G1 | 2.5-1.0 | 31 | R1 | 3.7-1.0 | 48 | R2 | 4.3-1.8 | | E2 | 0.6-3.0- |
| | NV | underdock | | E2 | 1.0-1.5- | | G1 | 1.8-1.2 | 62 | R2 | 4.3-2.7 |
| 16 | R1 | 3.7-2.0 | 32 | R1 | 4.3-2.0 | | E2 | 1.2-2.0- | | G2 | 2.7-1.2 |
| 17 | R1 | 3.7-2.0 | | G1 | 1.8-1.0 | 49 | R3 | 4.3-1.8 | | | |
| | E3 | 0.6-1.5- | | E2 | 1.0-1.5- | | G1 | 1.8-1.2 | | | |
| 18 | G1 | 2.7-0.6 | 33 | R2 | 4.3-1.2 | | L2 | 1.2-2.0- | | | |
| | NV | underdock | | G1 | 1.2-1.0 | | E2 | 1.2-2.0- | | | |
| | | | | E2 | 1.0-1.5- | | | | | | |

## 5.0 Biological Characteristics

### 5.1 Vegetation

Foreshore vegetation characteristics for reaches in Newcastle Island Passage and Nanaimo Harbour are listed in Table 2. A diagram showing typical zonation of vegetation in the marine foreshore of the study area is given in Figure 3. The aquatic vegetation in Newcastle Island Passage and Nanaimo Harbour was examined with a viewer both from land and from a boat and by S.C.U.B.A. diving. The vegetation composition was recorded and classified into the following categories:

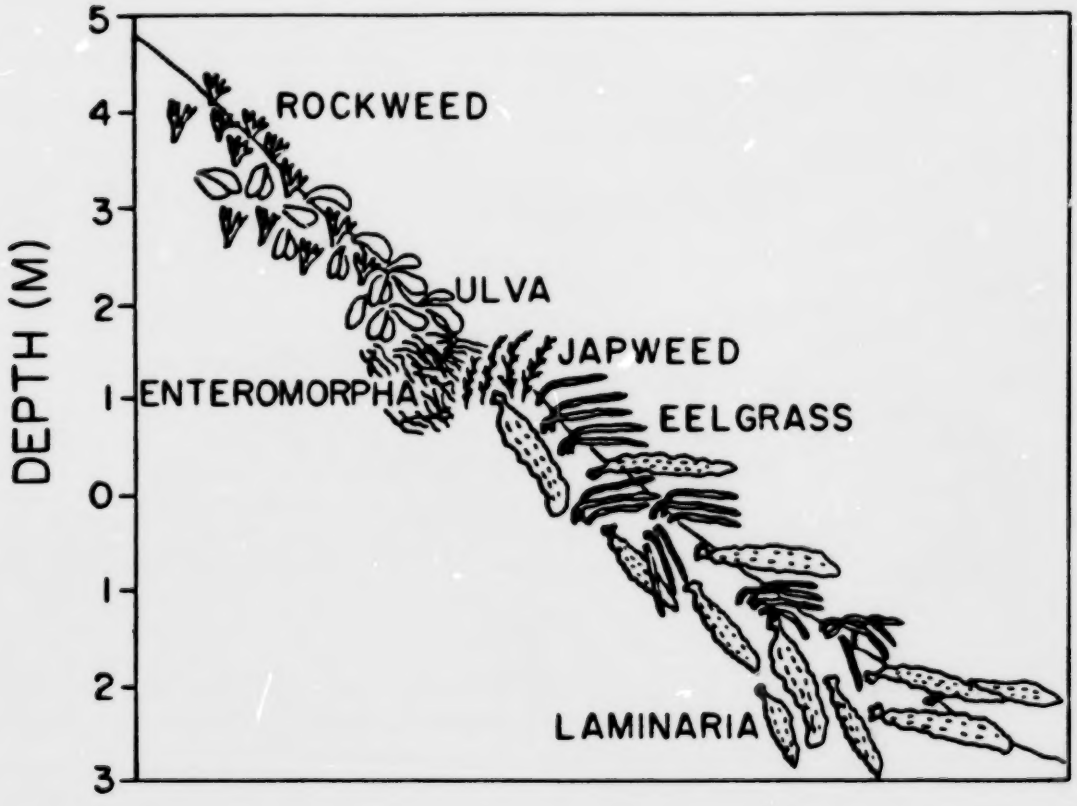
| | |
|---|---|
| R - rockweed | Density |
| G - Enteromorpha | 1 - sparse |
| L - laminaria | 2 - moderate |
| E - eelgrass | 3 - dense |
| J - japweed | |
| U - ulva | NV - no vegetation |

Rockweed is commonly found on bedrock and boulder substrates from 4.3 to 2.0 metres. Rockweed is most common on the Newcastle and Protection Island foreshore wherever there is bedrock and/or boulders. On the west foreshore of Newcastle Island Passage and Nanaimo Harbour rockweed is rare, occurring only in small patches on exposed bedrock and/or boulders.

Enteromorpha is the most common aquatic vegetation in the study area. It is found on all substrate types and occurs from 1.2 to 0.5 metres. Enteromorpha grows mainly on cobble and mud on the west foreshore of Newcastle Island Passage and all of the foreshore of Nanaimo Harbour. It is found mainly on bedrock and boulders on the east foreshore of Newcastle Island Passage.

Laminaria is found growing on shells, wood, rocks, and other attachment surfaces in the study area from 1.5 metres above to 2.0 metres below zero tide. Laminaria is common on the west foreshore of Newcastle Island Passage and the east foreshore of Nanaimo Harbour wherever a mud substrate, containing some type of attachment surface, occurs. It is also common on the east foreshore of Newcastle Island Passage and west foreshore of Nanaimo Harbour wherever bedrock and/or boulders occur.

# FIGURE 3
# FORESHORE VEGETATION ZONATION



Japweed is found on bedrock, boulders, or cobble in the study area. Japweed is rare, however, and only occurs at low densities in reaches 25 and 59.

Ulva grows mainly in one location in the study area: the Millstone River estuary. Here the seaweed exists on a mud substrate from 3.5 to 1.5 metres.

The location of major eelgrass beds in Newcastle Island Passage and Nanaimo Harbour are shown in Figure 4. Approximate sizes and densities of each bed are given in Table 3. Eelgrass occurs on mud and sand substrates from 1.0 metre above to 3.0 metres below zero tide in the study area. In many areas, individual eelgrass plants may reach 2.0 metres in length. On the west foreshore of Newcastle Island Passage and Nanaimo Harbour there are a few eelgrass beds in large patches between marinas and docks. The largest eelgrass bed occurs in the Millstone River estuary. On the east foreshore of Newcastle Island Passage and Nanaimo Harbour, eelgrass grows in long continuous beds following the shoreline in areas where a mud and/or sand substrate occurs.

In Newcastle Island Passage and Nanaimo Harbour aquatic vegetation, growing in the upper intertidal zone (rockweed) provides limited fish habitat. In the lower intertidal zone, however, the potential value of fish habitat increases. Enteromorpha and ulva, which occur just below rockweed in the intertidal, can provide important fish habitat especially if they occur on mud substrate. At the lowest point of the intertidal, and also occurring below zero tide, eelgrass and laminaria grow. Eelgrass thrives in shallow, sheltered areas with mud and sand substrates, and provides excellent shelter and food sources for fish. Laminaria may also provide suitable fish habitat if it is dense and/or it occurs with eelgrass.

Besides the six types of marine vegetation listed above, several other varieties of marine algaes have been described from research conducted in the vicinity (see Stephenson and Stephenson, 1961a and 1961b, and South, 1968). These other algaes were not recorded since their identification was beyond the scope of this study which intends to define only major vegetation zones.

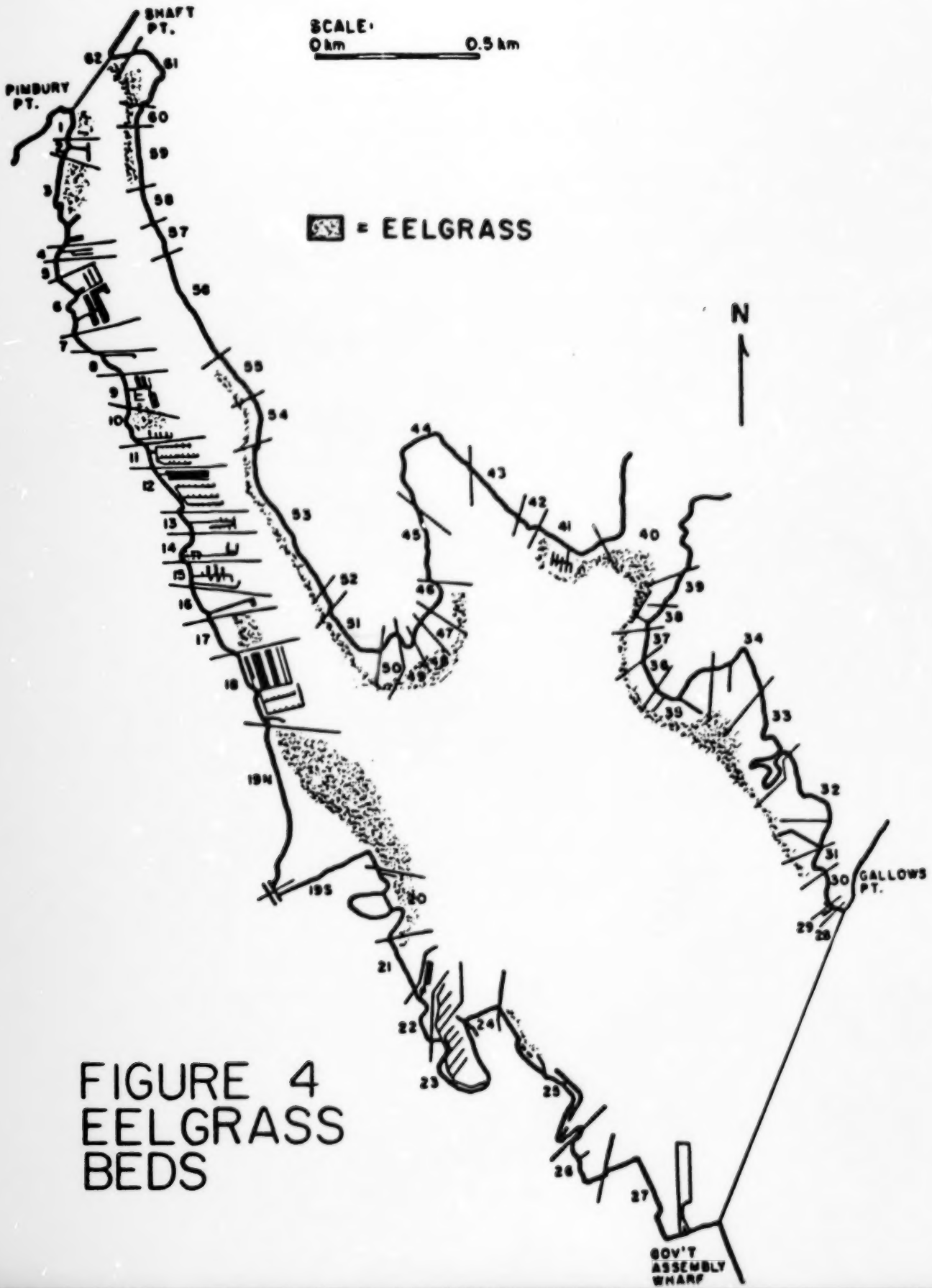



FIGURE 4
EELGRASS
BEDS

Table 3. Approximate Size and Density of Eelgrass Beds In Newcastle Island Passage and Nanaimo Harbour.

| Eelgrass Bed | Reach(es) | Size(ha) | Density(shoots/sq. m) |
|---|---|---|---|
| A | 1 | 0.35 | 32 |
| B | 3 | 0.92 | 32 |
| C | 9-10 | 0.51 | 44 |
| D | 17 | 1.09 | 36 |
| E | 19-21 | 6.40 | 60 |
| F | 25 | 0.32 | 36 |
| G | 31-41 | 6.46 | 40 |
| H | 46-55 | 11.30 | 40 |
| I | 59-62 | 1.92 | 36 |

## 5.2 Salmonids

In Newcastle Island Passage and Nanaimo Harbour there are two main rivers used by spawning salmonids; the Millstone and the Nanaimo. Smaller streams, such as the Chase River, Hong Kong Creek and Holden Creek also produce fish. Although the Millstone River is the only major salmonid producer in the study area, salmonids from the Nanaimo River and the other streams noted above also make extensive use of Nanaimo's fish habitat areas.

Since recording began in 1947, chum, coho, chinook, pink, and sockeye salmon, and steelhead, and cutthroat trout have all used the Nanaimo River for spawning. Chum, coho, steelhead, and cutthroat have spawned in the Millstone River.

Average salmon escapements for the 5 year period (1982-1986) to the Nanaimo River and the Millstone River were (estimates for the Nanaimo River include escapements to the Chase River, Hong Kong Creek, and Holden Creek):

| | Nanaimo River | Millstone River |
|---|---|---|
| Chum | 43,750 | 17 |
| Chinook | 1,480 | 0 |
| Coho | 2,628 | 194 |
| Pink | 3 | 0 |
| Sockeye | 1 | 0 |

More salmon data, showing escapement for the Millstone and Nanaimo Rivers for the past forty years, are given in Appendices I and II.

There are no steelhead and cutthroat data for the Millstone River, however, in 1978 and every year since 1981, steelhead enhancement has taken place in the river. In each year that enhancement has taken place 10,000 to 15,000 steelhead fry have been placed in the river, with an expected survival rate of 8% per year (Lou Carswell, Ministry of Environment and Parks, pers. comm.). Steelhead catch data over the 5 year period (1982-1986) for the Nanaimo River shows that per year an average of 2480 days were spent catching 1340 steelhead, of which 225 were hatchery fish. More steelhead data for the Nanaimo River, for the past 19 years, are presented in Appendix III. The number of cutthroat in the Nanaimo River is estimated at 5000 with 1000 being caught each year.

In addition to spawning salmon migrating through Newcastle Island Passage and Nanaimo Harbour, rearing salmon also use the study area. Juvenile salmonids from both the Millstone River and the Nanaimo River use the study area as a nursery. During the S.C.U.B.A. dive surveys chinook salmon smolts were seen along the west shore of Newcastle Island. Although chum, chinook, and coho juveniles from the Nanaimo River mainly use the Nanaimo River estuary for rearing, juveniles of these three species also rear in Newcastle Island Passage and Nanaimo Harbour. Healey et al. (1977) reports that of the three species of Nanaimo River salmon, juvenile chum are the principal salmon species using the study area as a nursery.

5.3 Herring

Use of Newcastle Island Passage and Nanaimo Harbour by spawning herring has not been recorded for over twenty-five years. Spawning herring, however, have used areas in the vicinity of the study area, specifically the eastern shore of Protection and Newcastle Islands as well as Departure Bay (Bell and Kallman, 1976). Bell and Kallman (1976) also report that the Nanaimo area is used by juvenile herring during their early life history. Juvenile herring may feed and migrate through Newcastle Island Passage and Nanaimo Harbour because there is some degree of shelter from prevailing winds and currents (Hourston, 1959).

5.4 Other Fish

Besides salmon and herring several other species of fish use Newcastle Island Passage and Nanaimo Harbour. Some of those fish, observed in the study area, include shiner perch, surf perch, pile perch, pricklebacks, and copper and quillback rockfish.

## 5.5 Shellfish

Several shellfish beds are found throughout Newcastle Island Passage and Nanaimo Harbour. Clam beds, located in reaches 13, 40, 54, 59, and 61, are usually found in mud or sand substrates from 1.2 to zero metres in the intertidal zone. Clams not only occur in dense beds but also in sparse clumps or as individuals along most of the shore of the study area. Clams occurring at low densities are found in mud substrates from 1.2 metres above to 3.0 metres below zero tide. Horse and butter clams are the most abundant species of clam found in Newcastle Island Passage and Nanaimo Harbour.

One large bed of pacific oysters is located in reach 51 of the study area. These oysters occur on boulders and bedrock from about 3.0 to 2.0 metres above zero tide.

Although closures for harvesting commercial and recreational shellfish in the study area are presently in effect due to bacterial contamination, these shellfish beds may still provide seed stock for nearby uncontaminated areas.

## 5.6 Crustaceans

Several species of crabs are found throughout Newcastle Island Passage and Nanaimo Harbour. Hairy and purple shore crabs are found under intertidal rocks. Kelp crabs are often found clinging to eelgrass and laminaria. Dungeness crabs live in eelgrass beds, often half-buried in the mud, and forage over the subtidal sandflats in the harbour. The most abundant crab in the study area, however, is the red rock crab, which occupies habitats similar to the dungeness crab as well as foraging among the cobbles and boulders so common in the passage.

Due to the easy access and relatively protected waters of the study area, Newcastle Island Passage and Nanaimo Harbour provide a significant recreational crab fishery area.

Commercial crab fishermen also use the study area. These crab fisherman, however, are reluctant to set traps in the area because of the high number of undersize crabs and because of vandalism. Approximately four crab fishermen use the study area (Randy Brahniuk, Fisheries Officer (Nanaimo), pers. comm.).

### 5.7 Other Invertebrates

Besides shellfish and crustaceans, several other invertebrates use Newcastle Island Passage and Nanaimo Harbour (see Stephenson and Stephenson, 1961a and 1961b). Invertebrates observed during the study, which represent only a small portion of the invertebrate species recorded in the area, include sea stars (ochre, leather, short spined, and sunflower), anemones (such as the plumose and painted tealia anemone), and various species of barnacles.

## 6.0 Intertidal Mudflats

The locations of the major intertidal mudflats in Newcastle Island Passage and Nanaimo Harbour are shown in Figure 5. Approximate sizes of each mudflat are given in Table 4. Shallow intertidal areas provide excellent fish habitat, especially if they are associated with mud substrates and vegetation. In the study area, the majority of these intertidal fish habitat areas occur on the west shore of Newcastle Island Passage and Nanaimo Harbour. The largest mudflat on the west shore, which provides excellent fish habitat, is the Millstone River estuary, located in reach 19. The importance of estuaries to juvenile salmonids and other marine organisms has been well documented and will not be discussed in this report. On the east shore of the study area there are two major intertidal fish habitat areas, specifically Mark Bay and the area between Newcastle and Protection Islands. Other intertidal foreshores within the study area are too steep and/or have bedrock, boulder, or cobble substrates which provide fish habitat of relatively lower value.

## 7.0 Foreshore Use

Foreshore use in the study area is documented in Table 5. Shoreline developments include 10 marinas (1 with a fuel station), 7 private moorage docks, 4 parks, 3 floatplane docks, 3 ferry terminals, 3 ship loading wharves, 2 shipyards, 3 launch ramps, 2 log booms, 3 breakwaters, and 1 fuel station. A large proportion of the foreshore on the west side of the study area is developed. The Newcastle Island foreshore is part of Newcastle Island Marine Park operated by the British Columbia Provincial Government. The only development in this part of the study area is a public moorage dock. Protection Island is a residential area and, therefore, its foreshore contains mostly private moorage.

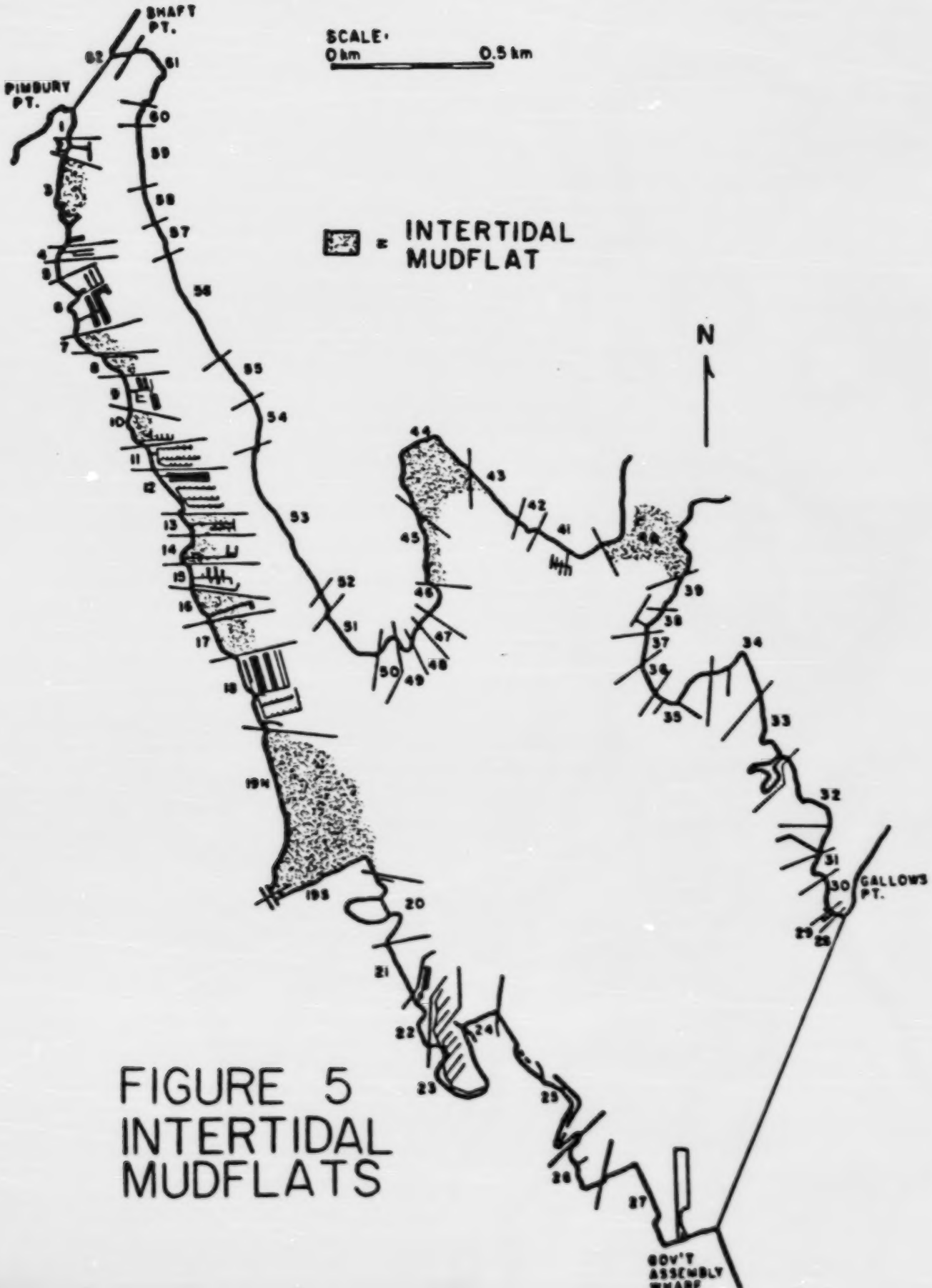



FIGURE 5
INTERTIDAL
MUDFLATS

Table 4. Approximate Size of Major Intertidal Mudflats In Newcastle Island Passage and Nanaimo Harbour.

| Intertidal Mudflat | Reach(es) | Size(ha) |
|---|---|---|
| A | 3 | 1.5 |
| B | 7-8 | 1.1 |
| C | 10 | 0.6 |
| D | 13-14 | 1.1 |
| E | 16-17 | 2.0 |
| F | 19 | 8.9 |
| G | 40 | 1.9 |
| H | 43-45 | 4.2 |

Table 5. Foreshore Use in Foreshore Reaches Defined In Newcastle Island Passage and Nanaimo Harbour.

M=marina; MF=marina with fuel station; C=shipyard; D=private moorage; F=fuel station; LB=log boom; FL=floatplane dock; B=breakwater; LR=launch ramp; P=park; SL=ship loading wharf; FT=ferry terminal

| Reach | Foreshore Use | Foreshore Use Type |
|---|---|---|
| 2 | Brechin Pt. Marina | F |
| 3 | Brechin Boat Ramps | LR,LR |
| | Float Plane Base | FL |
| 4 | Pat Johnstone's Marina | M |
| 6 | Stones Marine Centre | M |
| 8 | Petro-Can Bulk Terminal | SL |
| 9 | Anchorage Marina | M |
| 10 | Bluenose Chowder House | M |
| 11 | Newcastle Marina | M |
| 12 | Nanaimo Marina | M |
| 13 | Nanaimo Propeller Ltd. | C |
| 14 | Nanaimo Shipyard Ltd. | C |
| 15 | Moby Dick Boatel | M |
| 16 | Chevron Bulk Terminal | SL |
| 18 | Nanaimo Yacht Club | M |
| | Breakwater | B |
| 19N | Queen Elizabeth Promenade | P |
| 19S-20 | Maffeo/Sutton Park | P |
| | Newcastle Is. Ferry Terminal | FT |
| 21 | Georgia Park and Promenade | P |
| 22 | Pt. of Nanaimo Seaplane Base | FL |
| 23 | N.H.C. Commercial Inlet Basin | MF |
| | McCully Aviation | FL |
| 25 | Gabriola Ferry Terminal | FT |
| | CP new Ferry Terminal | FT |
| 26 | N.H.C. Assembly Wharf | SL |
| 29 | Breakwater | B |
| 30 | Public Boat Ramp | LR |
| 31-33 | Log Booms | LB |
| 32 | 2 Private Docks | D,D |
| 34 | Private Dock | D |
| 35 | 2 Private Docks | D,D |
| 38 | Private Dock | D |
| 39 | Private Dock | D |
| 40-62 | Newcastle Is. Park | P |
| 41 | Newcastle Is. Park Moorage | M |
| 43-45 | Log Booms | LB |

## 8.0 Habitat Evaluation

The majority of Newcastle Island Passage and Nanaimo Harbour is shallow and a significant portion is intertidal. This shallowness provides the study area with the capacity to be very productive and thus, has the potential to provide excellent fish habitat.

Sand and mud substrates contain large quantities of fish diet items. All of the foreshore reaches in the study area contain sand and/or mud substrates. In most cases, however, these substrates do not occupy the whole reach.

Most of the foreshore reaches in Newcastle Island Passage and Nanaimo Harbour contain extensive vegetation. Eelgrass beds exist along nearly 49% of the overall foreshore length of the study area. Eelgrass is an important form of aquatic vegetation because it provides shelter and food for many species of fish and shellfish as well as contributing significant quantities of carbon to the detrital food chain. In many cases, however, eelgrass beds do not occupy an entire reach. Other types of vegetation in the study area (i.e. laminaria) also provide important fish habitat by furnishing shelter and food for small fish.

## 9.0 Recommendations

This inventory provides an overview of the biophysical fish habitat characteristics of Newcastle Island Passage and Nanaimo Harbour. Since the characteristics of each reach in the study area may change through time, as the seasons change and/or as succession proceeds after developments occur, the assessment of individual developments should be made by individual on-site inspections.

The guiding principle behind the Department of Fisheries and Oceans policy for the management of fish habitat states that there be no net loss of the productive capacity of fish habitats. This principle implies that any fish habitat area lost due to development must be replaced with equivalent fish habitat by the developer.

Due to the presence of vegetation and sand and/or mud substrates along the entire foreshore of Newcastle Island Passage and Nanaimo Harbour, any potential developer must be prepared to replace any altered or lost fish habitat.

Mudflats containing extensive vegetation and eelgrass beds fronting rocky foreshore areas provide fish habitat of very high value. These areas should not be developed for any reason. In the study area, fish habitat areas of very high value include the entire Millstone River estuary and all other foreshore areas containing significant eelgrass beds.

Mudflat areas containing little vegetation and bedrock and/or boulder foreshore areas that are next to deep water and contain no eelgrass may be developed but only if suitable compensation for the fish habitat lost or altered can be found.

## 10.0 References

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Appendix I. Nanaimo River Salmon Escapement.

N/O = None Observed UN = Unknown NR = No Records

| Year | Chum | Chinook | Coho | Pink | Sockeye |
|---|---|---|---|---|---|
| 1947 | 35,000 | 3,500 | 750 | 1,500 | 0 |
| 1948 | 35,000 | 3,000 | 500 | 400 | 25 |
| 1949 | 20,000 | 800 | 1,200 | 1,500 | UN |
| 1950 | 100,000 | 750 | 3,500 | 400 | UN |
| 1951 | 75,000 | 3,500 | 7,500 | 1,500 | 25 |
| 1952 | 35,000 | 3,500 | 3,500 | 750 | 0 |
| 1953 | 35,000 | 1,500 | 7,500 | 750 | 0 |
| 1954 | 75,000 | 1,500 | 7,500 | 200 | 0 |
| 1955 | 15,000 | 3,500 | 3,500 | 200 | 0 |
| 1956 | 35,000 | 3,500 | 7,500 | 25 | 0 |
| 1957 | 35,000 | 7,500 | 15,000 | 750 | 25 |
| 1958 | 75,000 | 3,500 | 3,500 | 200 | UN |
| 1959 | 7,500 | 3,500 | 1,500 | 25 | UN |
| 1960 | 3,500 | 750 | 1,500 | 25 | UN |
| 1961 | 7,500 | 750 | 750 | UN | UN |
| 1962 | 7,500 | 750 | 1,500 | 0 | 0 |
| 1963 | 3,500 | 1,500 | 1,500 | 0 | 0 |
| 1964 | 15,000 | 750 | 3,500 | 0 | 0 |
| 1965 | 15,000 | 3,500 | 1,500 | UN | UN |
| 1966 | 75,000 | 1,500 | 3,500 | 0 | 0 |
| 1967 | 22,000 | 1,200 | 6,000 | 0 | N/O |
| 1968 | 26,000 | 1,500 | 800 | 0 | N/O |
| 1969 | 26,000 | 1,100 | 1,200 | 0 | 0 |
| 1970 | 30,000 | 1,500 | 4,750 | UN | 0 |
| 1971 | 17,500 | 850 | 4,250 | UN | UN |
| 1972 | 70,000 | 1,950 | 2,250 | UN | 1 |
| 1973 | 36,000 | 1,200 | 1,500 | 0 | 0 |
| 1974 | 38,000 | 2,400 | 4,800 | 0 | 0 |
| 1975 | 15,000 | 525 | 1,500 | UN | UN |
| 1976 | 14,000 | 1,100 | 850 | UN | UN |
| 1977 | 48,000 | 2,800 | 4,800 | UN | UN |
| 1978 | 46,800 | 2,500 | 900 | UN | 2 |
| 1979 | 36,000 | 4,370 | 2,500 | 14 | 5 |
| 1980 | 50,000 | 2,826 | 4,000 | 30 | 6 |
| 1981 | 35,000 | 300 | 3,000 | 30 | UN |
| 1982 | 50,000 | 1,440 | 4,250 | N/O | 3 |
| 1983 | 46,400 | 1,606 | 2,100 | 1 | N/O |
| 1984 | 45,000 | 3,000 | 2,700 | N/O | N/O |
| 1985 | 50,350 | 2,546 | 650 | 12 | 2 |
| 1986 | 27,000 | 1,540 | 700 | N/O | N/O |

Appendix II. Millstone River Salmon Escapement.

N/O = None Observed UN = Unknown NR = No Records

| Year | Chum | Chinook | Coho | Pink | Sockeye |
|---|---|---|---|---|---|
| 1947 to 1980 | ********NO RECORDS********** | | | | |
| 1981 | 8 | NR | 2 | NR | NR |
| 1982 | NR | NR | NR | NR | NR |
| 1983 | NR | NR | 350 | NR | NR |
| 1984 | NR | NR | 300 | NR | NR |
| 1985 | 20 | N/O | 200 | N/O | N/O |
| 1986 | 65 | N/O | 120 | N/O | N/O |

Appendix III. Nanaimo River Steelhead Catch Data.

NR = No Record

| Year | Days Fished | Total Catch | Hatchery Catch |
|---|---|---|---|
| 1968 | 4500 | NR | NR |
| 1969 | 6500 | NR | NR |
| 1970 | 7200 | NR | NR |
| 1971 | 3400 | 700 | NR |
| 1972 | 3500 | 1100 | NR |
| 1973 | 4800 | 1700 | NR |
| 1974 | 4500 | 1000 | NR |
| 1975 | 4300 | 1100 | NR |
| 1976 | 8400 | 2000 | NR |
| 1977 | 5400 | 1100 | NR |
| 1978 | 4600 | 1300 | NR |
| 1979 | 6800 | 1700 | NR |
| 1980 | 3300 | 800 | NR |
| 1981 | 2100 | 1000 | NR |
| 1982 | 1700 | 900 | NR |
| 1983 | 2700 | 1100 | 100 |
| 1984 | 2600 | 1300 | 150 |
| 1985 | 3000 | 2200 | 400 |
| 1986 | 2400 | 1200 | 250 |